WAVETEK

OPERATOR'S MANUAL

Series 2000
Digital Multimeters
Models 2010, 2020, 2030

WARNINGS AND PRECAUTIONS

PLEASE READ SECTION II—SAFETY INFORMATION AND SECTION IV—OPERATION REGARDING "WARNINGS AND PRECAUTIONS."

Exceeding the maximum limits of this instrument is DANGEROUS.

Exceeding these limits will expose you to physical injury or even death and will almost certainly damage your instrument. Even low-level voltages and currents are capable of causing serious injury or even death.

Please do not use this or any piece of test equipment without proper training. Individual functions and ranges have different overload limits. It is VERY IMPORTANT that you make yourself aware of these overload limits. Check the specifications of these overload limits. Check the specifications in SECTIONS II and VII for specific overload limits.

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Series 2000
Digital Multimeters
Models 2010, 2020, 2030

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Warranty

3 Year Limited Warranty

The Series 2000 Digital Multimeters are warranted against all defects of material or workmanship which develop for any reason whatsoever, except abuse, within a period of three (3) year from the date of purchase of the multimeter by the original buyer. This warranty is extended only to the original buyer or original user of the multimeter, who must present proof of purchase at the time of warranty service.

In the USA any multimeter claimed to be defective during the warranty period should be returned with proof of purchase to an authorized Wavetek Corp. Factory Service Center. Follow the shipping instructions as detailed in the service section at the back of this manual. For warranty repair outside the USA, contact your local Wavetek dealer, or distributor where your multimeter was purchased, or return it to an authorized Wavetek Corp. Factory Service Center.

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Section I Introduction

The Wavetek Series 2000 professional quality autoranging digital multimeters (DMMs) offer many sophisticated functions and features. The Series 2000 meters measure voltage, current, resistance, capacitance, frequency, duty cycle, logic transitions, and test both continuity and diode junctions. Front panel push buttons allow the user to select from a menu of special features including Range Lock, Probe Hold™, Auto Relative Mode, Auto Min Max Avg, and Peak Hold (2020/2030).

This manual covers the 2010, 2020, and 2030 meters. Except where noted, the units are the same.

For most functions, the meter operates in one of two modes, Range Lock or Autoranging.

- Range Lock allows the operator to confine the meter scale to a specific range.
- Autoranging provides fast automatic adjustment of the measurement range.

Unpacking and Inspection

Remove the multimeter from the shipping container. The box should contain the following:

1. Multimeter
2. Holster with Tilt Stand with Flex Strap™
3. Test leads (one black, one red)
4. Nine volt battery (installed)
5. Operator's Manual.

Account for and inspect all of these items. If any of the items are damaged or missing, immediately return the complete package to the place of purchase for an exchange.

Note:
Retain the shipping container for use if the instrument must be returned for exchange or repair.

Each Wavetek Series 2000 meter has a compact profile for easy handling. Designed to withstand the rigors of the real world, the meters are enclosed in a tough, internally-braced case with protective holster. Each unit is splash proof and maintains a high degree of accuracy over a wide range of temperatures and humidities.

The following table provides brief descriptions of some of the meter's special features.

Feature	Description
Auto Min-Max Avg	Records minimum, maximum and average readings.
Auto Power Down	Turns off multimeter after 30 minutes of no activity.
Auto Rel™	Displays measured value relative to a measured reference value.
Backlight	Illuminates LCD (2020, 2030)
Dangerous Voltage Alert	Displays a warning symbol when the input voltage is dangerous (> 25V).
Fault Finder™	Issues tones which vary according to the measured value.
Low Battery Cutoff	Blanks display after 20 hours of low battery use ( ) to prevent erroneous readings.
Overload Alert™	Displays a warning and issues a tone when the input exceeds meter limits.
Peak Hold	Records minimum and maximum peak readings (2020,2030).
Probe Hold™	Retains reading for viewing after measurement is taken.
Range Lock	Confines the meter to a set range.
True RMS (AC/AC + DC)	Measures the RMS value of nonsinusoidal waveforms. (2020, 2030)

Table 1: Meter Features

Symbols Used in This Document

This table provides brief definitions for most of the symbols used in this document or by the instrument.

Symbol	Definition
	Attention! Refer to the instructions for details. Dangerous voltage may be present at terminals, use extreme caution.
A~	AC (Alternating Current)
A⎓	DC (Direct Current)
	Diode Test, Audible Continuity
	Dangerous Voltage
A	Ampere (Current)
Ω	Ohm (Resistance)
	Capacitance
Hz	Hertz (Frequency)
	Logic Symbol (Pulse Detector Function)
	Select Feature
	Deselect Feature
	Cycle menu to left
	Cycle menu to right
	Low Battery
+/–	Polarity of input signal
%	Duty Cycle

Table 2: Symbols

The following table provides a brief comparison of the special features in the 2010, 2020, and 2030 meters.

Feature	2010	2020	2030
ACV/DCV	•	•	•
True RMS		•	•
ACA/DCA	•	•	•
Ohms	•	•	•
Diode Test/Continuity	•	•	•
Capacitance	•	•	•
Frequency/Duty Cycle	•	•	•
Logic Signal Detection	•	•	•
Probe Hold™	•	•	•
Relative Mode	•	•	•
Auto Min/Max Average	•	•	•
Fault Finder™	•	•	•
Peak Hold		•	•
Fiberoptic Backlight		•	•

Table 3: Meter Special Features Comparison

Section II Safety Information

This manual contains important safety information and warnings, which must be followed in order to ensure safe operation and to protect the user from serious injury or death.

WARNINGS!

When "W" is used in this manual it advises the user of a hazard that could result in serious injury or even death. The "W" refers the user to the WARNINGS below and in the operating instructions in Section IV.

PRECAUTIONS!

When "P" is used in this manual it advises the user of a hazard that could cause damage or malfunction in the instrument. The "P" refers the user to the PRECAUTIONS below and in the operating instructions in Section IV.

"W" Since injury or death can occur even with low voltages, exercise extreme caution when measuring: voltage above 20V, AC mains with inductive loads, or measuring AC mains during electrical storms.

Measuring a voltage which exceeds the meter limits may expose the user to a dangerous shock, serious injury, or even death. The equipment may be damaged, too. The limits for the meter are:

VDC:	1000V (max.)	Maximum voltage between any terminal and ground is 1000V.
VAC:	1000V (max.)	Circuit under test must be protected by a 20A fuse or circuit breaker.

"W" Both the low and high current jacks are protected by fuses; however, to avoid damage or injury, use only in circuits limited to the following current levels with a maximum of 600V:

100mA Current Jack	100mA Continuous
10A Current Jack	10A Continuous 20A for 30 Seconds

Overload and Transient Protection

All voltages and resistance ranges are protected against voltage transients in conformance to IEEE-587 STD Category B, Table 1 (1.25 x 50µs, amplitude 6kV). Current ranges are protected by 600V fuses of either .25A or 15A rating. The high current input is protected to an energy limit of 100,000A when a factory recommended fuse is installed.

"W" Warnings and Precautions

"P" Do not attempt to measure voltages or currents that may exceed the ratings marked on the Function/Range Switch or terminal overlays.

Use extreme caution when working near high voltage sources. This includes any voltage measurements requiring the use of the two highest VAC or VDC ranges.

To avoid electrical shock hazard and/or damage to the multimeter, do not measure voltages that might exceed the maximum voltage rating above earth ground.

Operator injury or damage to the multimeter may occur during current measurements if the fuse blows in a circuit which exhibits an open circuit voltage greater than 600 volts.

Before each use of the multimeter, inspect test leads, connectors, and probes for cracks or breaks in the insulation. If any defects are found, replace item immediately.

To avoid electrical shock hazard, do not touch test leads, tips, or the circuit being tested while power is applied to the circuit being measured.

"P" **Exceeding the maximum input overload limits can damage the multimeter.**

When measuring current, check that the multimeter is connected in series with the load in which the current is to be measured. NEVER connect the multimeter ACROSS a voltage source. To do so can result in either blowing the overload protection fuse or damaging the device being tested.

Overload Indication

The multimeters are equipped with automatic overload indication. This means that whenever an input signal is larger than the range selected, an overload symbol (OL) will appear in the Digital Display. This feature allows the user to test devices with unknown circuitry where an overload condition might exist but would not exceed the capability of the multimeter.

"W" **"OL" indicates that the meter's maximum voltage or current input level has been exceeded. Remove the test probes from the circuit immediately.**

Do not use the Flex-Strap™ to attach the meter to your body.

Malfunction of the unit may expose the user to a dangerous shock, other serious injury, or even death.

"P" **Range overload is indicated by "OL" or "OPEN" in display. This is normal in the OHMS range when the leads are not connected to anything. In all other situations, a continuous tone will sound.**

The meter will issue a continuous warning tone when the input voltage and current levels have been exceeded. Table 4 lists the overload levels.

Functions	Display Level (Max.)	Overload Level
AC Voltage	1020.9 volts	1021 volts
DC Voltage	1020.9 volts	1021 volts
Resistance	20.49M	—
Diode/Continuity	1.9999VDC	>2VDC
Logic Signal (DCV)	1020.9 volts	1021 volts
100mA (AC/DC)	102.09mA	102.10mA
10A (AC/DC)	20.49A	20.50A

Table 4: Overload Levels

Voltage Measurements

"W" "P" CRT SERVICE REMINDER: A POTENTIAL DANGER TO YOU AND YOUR METER EXISTS WHEN MEASURING VOLTAGES IN THE HORIZONTAL OUTPUT AND DAMPER STAGES OF CRT EQUIPMENT. THIS DANGER IS CAUSED BY THE HIGH VOLTAGE TRANSIENTS (GREATER THAN 6,000 VOLTS) THAT OCCUR IN THESE CIRCUITS. PLEASE REFER TO YOUR CRT SERVICE MANUAL FOR PROPER SERVICING INSTRUCTIONS.

Section III Functional Description

The following figure shows the 2030 front panel. A description of each control and indicator follows.

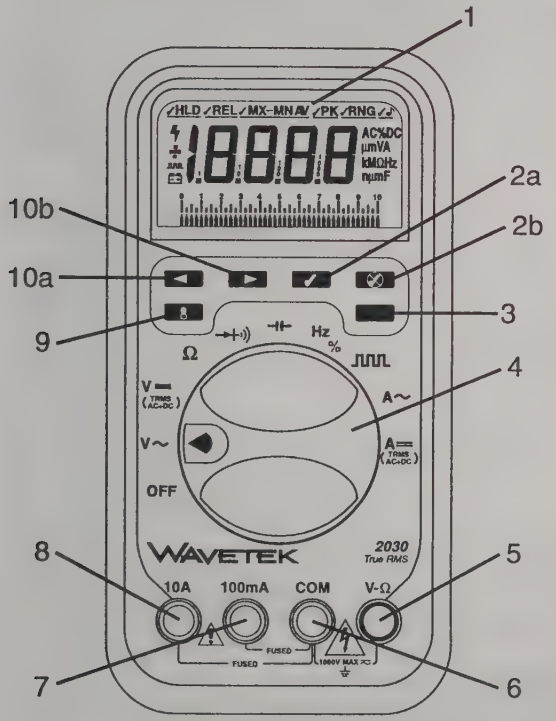


Figure 1: 2030 Front Panel Layout

1. **LCD Display**
The LCD Display consists of a 5 digit (18888) primary display, an analog bar graph, and a number of annunciators and symbols.

2a. **SELECT**
Used to select the feature above the cursor.

2b. **DESELECT Key**
Used to deselect or cancel the feature above the cursor.
See Section V: Special Features for details.

3. **2nd Function Key**
The 2nd function key is used to select the AC+DC measurement mode when the Function Selector Switch is set to DCV (True RMS AC+DC measurements) or DCA (True RMS AC+DC measurements). Also used to select Duty Cycle when the Function Selector Switch is set to Hz and to reset Peak Hold. It will also turn the meter ON after Auto Power Off.

4. **Function Selector Switch**
The Function Selector Switch allows the operator to turn the meter on or off and select a function. Once the desired function is selected, the meter is ready for normal operation.

5. V-Ω **Voltage/Resistance Jack**
A test probe is connected to this jack for all functions except current.

6. COM **Common Jack**
The Common Jack is the common input test probe connector for all measurements.

7. 100mA **100mA Current Jack**
A test probe is connected to the 100mA Jack when testing currents that range from 0.1μA to 100mA.

8. 10A **10A Current Jack**
A test probe is connected to the 10A Jack when testing currents that range from 0.1mA to 10A.

9. **Backlight Button**
ON/OFF toggle for LCD backlight. Automatically turns off after 60 seconds. Press ON, press OFF. (2020, 2030).

10a. **Left MENU Button**
Turns on Menu, engages cursor, and moves cursor left across menu.

10b. **Right MENU Button**
Turns on Menu, engages cursor, and moves cursor right across menu.

11. AC DC **AC/DC Annunciator**
This annunciator indicates the type of input current and voltage: Alternating Current (AC) or Direct Current (DC).

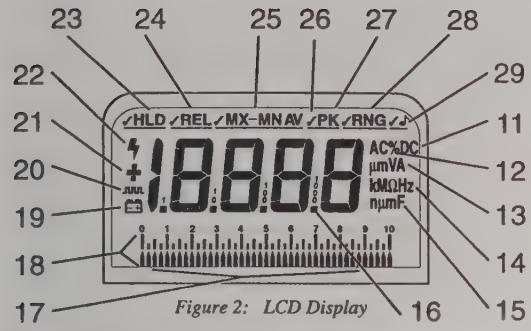


Figure 2: LCD Display

12. **%** **Duty Cycle**
This symbol indicates that Duty Cycle has been enabled.

13. **μmVA** **Units Annunciator**
This annunciator indicates the range scale for current and voltage measurements. It indicates micro (μ) or milli (m), volts (V) or amps (A).

14. **kMΩHz** **Units Annunciator**
This annunciator indicates the range scale for resistance and frequency measurements. It indicates kilo (k), mega (M), ohms (Ω) or Hertz (**Hz**).

15. **nμmF** **Units Annunciator**
This annunciator indicates the range scale for capacitance measurements. It indicates nano (n), micro (μ), or milli (m) farads (F).

16. **Decimal Point/Range Indicator**
Indicates numerical value, 1, 10, 100, 1000 of range.

17. **Bar Graph Indicator**
This symbol is a "needle" that moves along the bar graph.

18. **Analog Bar Graph**
The 41 segment analog bar graph provides a visual indication of the measurement with respect to the boundaries of the range.
Scale is 0 to 100% of the range.

19. **Battery Alert**
This symbol indicates that less than 20 hours of battery life remain. When the battery fails the internal self test, meter will turn itself off. To ensure accuracy, replace the battery as soon as the low battery warning comes on. The meter performs self test on power-up. If it fails self test, it won't power up.

20. **Logic Signal Indicator**
This symbol indicates the Pulse Detector function, which is used to detect voltage transitions in digital signals.

21. **Polarity Indicator**
This symbol indicates the polarity of the input signal, positive (+) or negative(-).

22. **Dangerous Voltage**
This symbol indicates that a dangerous voltage may be present at the terminals. When the input exceeds 25V (AC or DC), this symbol will be displayed and a double tone will be issued.

> **"W" Exercise extreme caution when the meter displays the dangerous voltage symbol.**

23. ✓HLD **Probe Hold™**
Probe Hold™ allows the operator to take a measurement and then remove the probes from the circuit while the measured value remains displayed for later viewing.

24. ✓REL **Auto Relative (Auto Rel™)**
Relative Mode allows the operator to measure values with respect to a preset reference value.

25. ✓MX-MN AV **Auto Min Max™**
Auto Min Max™ allows the operator to measure and record the minimum and maximum values while the meter displays real time data. The recorded minimum and maximum levels will be automatically updated when the input exceeds the previous value stored in its memory. Also displays Max-Min and the average.

26. ✓ **Cursor**
This symbol highlights feature for select, deselect or further operations.

27. ✓PK **Peak Hold**
This symbol indicates the meter will display the peak value (1mS wide) of a series of measurements (2020,2030).

28. ✓RNG **Range**
Range Lock allows the operator to "lock" the meter scale into a desired display range.

29. ✓♪ **Tone**
This symbol indicates the Fault Finder™ has been enabled.

Audible Feedback

The Series 2000 multimeters provide several types of audible feedback.

Single tone of short duration when:

- a function is changed.
- a menu select occurs, in either direction.
- the Select or Deselect button is pressed.
- a diode tests as good.
- the LCD backlight is switched on or off.

Double tone when:

- a dangerous high voltage input exists (over 25 volts).
- Min or Max values are updated.

Single tone of long duration when:

- the Probe Hold™ is updated.

Continuous tone when:

- the Continuity Test shows continuity.
- the input voltage or current exceeds the maximums allowed.

Continuous beeping when:

- the probe has been connected to the 10A Jack and a function other than current has been selected. (Incorrect Input Warning)

Auto-Power Down (Battery Saver)

After about 30 minutes of inactivity the meter will turn off automatically. To turn the meter back on again, move the Function Selector Switch to Off and then to any function, or press 2nd function button.

When in the Auto Min Max Avg mode and Peak Hold, the meter *will not* power down by itself. This allows for extended monitoring of the input signal.

Analog Bar Graph

The analog bar graph provides a visual indication of the measurement with respect to the boundaries of a selected range in terms of percent of the range. The needle will move horizontally across the display to indicate the percent value.

Application:

The analog bar graph updates 20 times a second and will display information much more rapidly than the digital display. The analog display is excellent for peaking and nulling circuits, locating noisy resistance measurements or the presence of AC on a DC measurement.

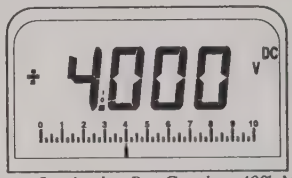


Figure 3: Analog Bar Graph at 40% Mark

Example:

The input is 4V and the range is set to 10V. In this case, the input is 40% of the range value, so the needle will move to the 4 on the graph.

True RMS Measurement

Model 2010 is capable of average-responding measurements, while the 2020 and 2030 are capable of both average-responding and True RMS measurements (see measuring "true RMS" voltage for details). Models 2020 and 2030 permit the direct measurement of the Total Effective Voltage or True RMS (AC+DC) value of a signal. This is useful when measuring nonsinusoidol waveforms or waveforms containing harmonics such as the output of power control circuits and switching power supplies, as well as input signals with both AC and DC voltages present.

Average-Responding RMS Measurement

Understanding the AC conversion process in the multimeter will help you more fully use its measuring capabilities. Most digital multimeters contain "average-responding" converters. An RMS value is determined by first rectifying and filtering the signal to obtain the average value. The average value is then scaled upward by a factor of 1.11 to obtain the RMS value. The scaling factor of 1.11 is accurate in the measurement of sine wave signals for which the relationship between the average and the RMS values is as follows:

$$V_{RMS} = \frac{V_{average}\,\pi}{2\sqrt{2}} = 1.11\,V_{average}$$

In measuring nonsinusoidal waveforms, however, significant errors can be introduced because of different scaling factors relating average to RMS values. Rough correction factors can be sometimes calculated for standard waveforms that are free from significant noise and distortion, but accurate measurements of complex waveforms can be difficult to achieve.

True RMS Responding Converter (2020, 2030)

RMS values of nonsinusoidal signals can be measured directly and more accurately with the True RMS responding converter used in the Model 2020 and 2030. True RMS response can be particularly useful in measuring complex or noisy signals for which even rough correction factors cannot be easily computed. The relationship between the total True RMS (AC+DC) and the component AC and DC signals is given by the following expression.

$$total_{RMS} = \sqrt{(AC_{RMS}\ Component)^2 + (DC\ Component)^2}$$

Converters of all types are limited by their frequency response and input dynamic range. Bandwidth defines the range of frequencies in which the conversion accuracy is within 3 decibels. The bandwidth for the Model 2020 and 2030 is 5kHz. Measurements of complex signals will not be affected by converter bandwidth limitations unless there are significant harmonic components beyond 5kHz.

Both the 2020 and 2030 are capable of measuring two types of True RMS. The first, Total Effective Voltage, is as calculated in the equation above. This measurement is performed in the DC volts function after the 2nd function button is pressed. Both the AC and DC annunciators will appear. When the DC annunciator is illuminated only DC Volts will be displayed. The second type of True RMS measurement, Total Effective AC Voltage, is performed in the AC Volt function at all times. During this measurement only the AC_{RMS} component is displayed.

Crest Factor

Crest factor is a measure of the input dynamic range of a True RMS responding converter. It expresses the capability of the converter to handle a signal that has large peak values compared to its RMS value without saturating the converter circuitry and degrading the specified accuracy.

The crest factor is defined as the ratio of the peak voltage to the total RMS (AC+DC) voltage.

$$Crest\ Factor = \frac{V_{peak}}{V_{RMS}}$$

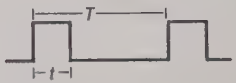
Crest Factor for an AC coupled pulse train is as follows:

$$\text{Crest Factor} = \frac{1}{Y}$$

where

$X = t/T$

$Y = \sqrt{X - X^2}$



At half scale, signals with a crest factor between 1.0 and 3.0 can be measured without performance degradation. At or below 2500 counts, signals with crest factors up to 5.0 can be measured. If the crest factor is not known, it can be determined by measuring the peak voltage using the Peak Hold feature and dividing by the RMS voltage measured by the multimeter.

$$\text{Crest Factor} = \frac{\text{peak voltage}}{\text{RMS voltage}}$$

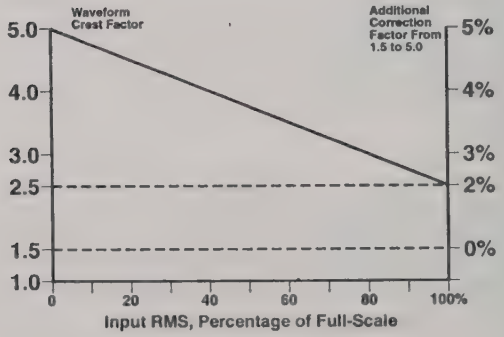


Figure 4: Accuracy Versus Crest Factor.

The crest factors for some typical waveforms are shown in the following table:

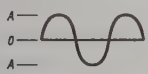
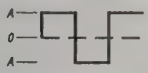
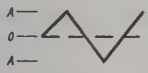
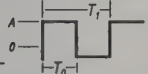
Input Waveform \ Crest Factor (CF)	True RMS AC on DC (2020, 2030)	True RMS AC only (2020, 2030)	Averaging Responding (2010)
Sine 	0.707 A CF = 1.414	0.707 A CF = 1.414	0.707 A
Square 	1.000 A CF = 1.000	1.000 A CF = 1.000	1.111 A
Triangle 	0.577 A CF = 1.733	0.577 A CF = 1.733	0.555 A
Full Wave Rectified Sine	0.707 A CF = 1.414	0.308 A CF = 3.247	0.298 A
Half Wave Rectified Sine	0.500 A CF = 2.000	0.386 A CF = 2.591	0.389 A
50% Duty Cycle Pulse Train	0.707 A CF = 1.414	0.500 A CF = 2.000	0.555 A
Variable Duty Cycle Pulse Train  $X = T_0/T_1 \quad Y = \sqrt{X - X^2}$	$A\sqrt{X}$ $CF = \frac{1}{\sqrt{X}}$	AY $CF = \frac{1}{Y}$	1.111 AY

Table 5: Waveforms and Crest Factors

Section IV Operation

This section provides general operating instructions for the Series 2000 digital multimeters.

Holster/Tilt Stand

The Holster/Tilt Stand, shown in the following figure, protects the meter from accidental falls and provides greater ease of use. The tilt stand allows for two viewing angles and features "living hinges"—good for more than one million cycles. The operator can use the Flex-Strap™ to hang the meter for more convenient use.

To eliminate "three-handed" operations, the holster has a holder for the test probe. This allows the operator to grip the holster and attached test probe in one hand, while using the remaining test probe in the other hand. The probe holder is also designed to provide safe and convenient storage for the probe. Stow the probes by pushing the probe ring into the retainer slot in the holder.

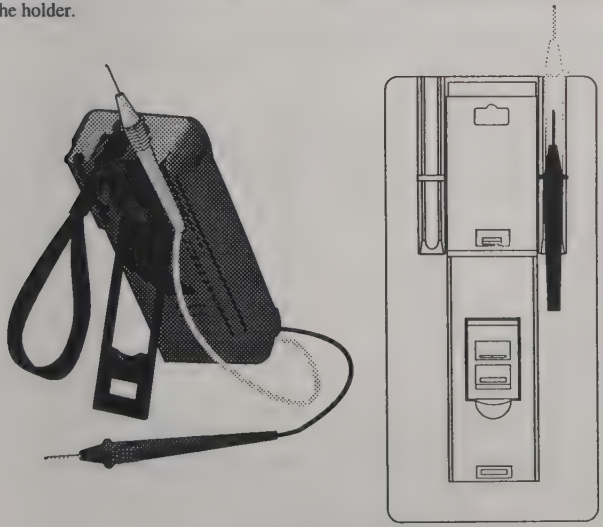


Figure 5: Holster/Tilt Stand

Menu Operation

The MENU buttons are used to select the various features of the multimeter. When either ◄ ► is pushed the menu selections begin blinking.

◄ will activate the menu and cursor √___ and move the cursor √___ to the left.
► will activate the menu and cursor √___ and move the cursor √___ right.
✓ will engage the underlined feature.
⊗ will disengage the underlined feature.
⊗ twice will disengage all selected features.

Setting the rotary Function Selector Switch to the OFF position or changing the function clears all features from the meter's memory.

Once a feature has been selected the meter is available for immediate use even if unselected functions remain in the display. If no other features are selected the remaining unselected features turn off after several seconds.

The following table shows which functions and features can be used together.

Functions	Probe Hold™	Range Lock	Auto Relative Mode	Auto Min Max Avg.	Peak Hold	Fault Finder™ (♪)	Bar Graph
AC Voltage	√	√	√	√	√	√	√
DC Voltage	√	√	√	√	√	√	√
Resistance	√	√	√	√		√	√
Diode/Continuity	√		√	√			√
Capacitance	(1)	√	√	√		√	(1)
Freq./Duty Cycle	(1)		√	√			
Logic Signal (DCV)	√	√	√	√			√
AC Current	√	√	√	√	√	√	√
DC Current	√	√	√	√	√	√	√

(1) Refer to specific section on function for details.

Table 6: Features Available with Each Electrical Function

2nd Function Key

The 2nd Function Key is used to access three additional functions:

1. Selects True RMS, AC + DC readings, in DC Volts and DC Current (2020, 2030).
2. Selects Duty Cycle in Frequency Function.
3. Resets Peak Hold reading so Meter can accept a new Peak reading (2020, 2030).

The 2nd function keys will also turn the meter ON after auto-power down. Both True RMS and Duty Cycle measurements are discussed in detail later in section. Peak Hold is discussed in Section V.

Measuring AC Voltage

1. Select AC Volts V~.
2. Attach the probe tips to the voltage source as shown in the following figure. The LCD will show dashes until the reading has stabilized. The voltage will then appear in the display, as will the appropriate Unit Annunciator. The Bar Graph indicator will move to the appropriate position on the Bar Graph scale.
3. If the voltage is too high, or the voltage exceeds the set range, "OL" will appear in the display.

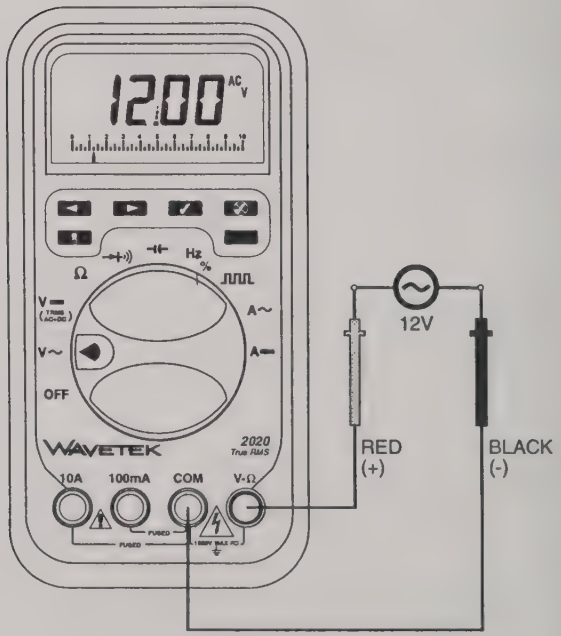


Figure 6: AC Voltage Measurements

"W" **To avoid shock hazard, injury, and meter damage, do not apply more than 1000VDC or peak AC between any meter input jack and earth ground. Circuit under test must be protected by a 20A fuse or circuit breaker.**

"W" "P" **CRT Service Safety Reminder: A potential danger to you and your meter exists when measuring voltages in the horizontal output and damper stages of CRT equipment. This danger is caused by the high voltage transients (greater than 6,000 volts) that occur in these circuits. Please refer to your CRT service manual for proper servicing instructions.**

Note:

For instruction on measuring True RMS AC voltage, refer to page 26.

Measuring DC Voltage

1. Select DC volts V⎓.
2. Attach the probe tips to the voltage source as shown in the following figure. The LCD will show dashes until the reading has stabilized. The voltage will then appear in the display, as will the appropriate Unit Annunciator. The Bar Graph indicator will move to the appropriate position on the Bar Graph scale.
3. If the voltage is too high, or the voltage exceeds the set range, "OL" will appear in the display.

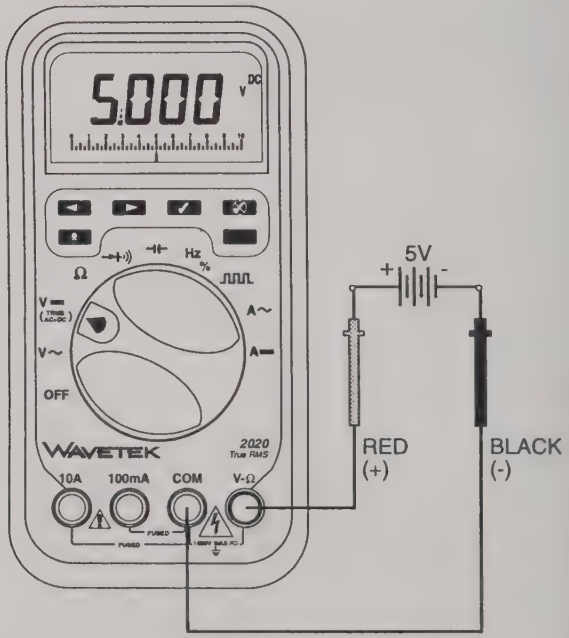


Figure 7: DC Voltage Measurements

Note:

For accurate measurement of DC voltages with the presence of AC voltages, measure the AC voltage first. Record the AC range and Range Lock the meter in a DC range equal to or greater than the AC range.

"W" **To avoid shock hazard, injury, and meter damage, do not apply more than 1000VDC between any meter input jack and earth ground. The circuit under test must be protected by a 20A fuse or circuit breaker.**

"P" **A potential danger to you and your meter exists when measuring voltages in the horizontal output and damper stages of CRT equipment. This danger is caused by the high voltage transients (greater than 6000 volts) that occur in these circuits. Please refer to your CRT service manual for proper servicing instructions.**

Measuring True RMS Voltage (AC + DC coupled) Models 2020 and 2030 only

1. Measure the AC Component. Remember AC Voltage Range.
2. Select DC Volts ⎓.
3. Press the ▒ second function button to invoke True RMS. The AC and DC annunciators will both turn on.
4. Press the ✓ select button until the DC Voltage Range is the same as the AC Voltage measured in step 1.
5. The LCD will show dashes until the reading has stabilized: the Bar Graph will then indicate the AC component of the input signal.
6. If the voltage is too high, "OL" will appear in the display. Select appropriate range.

"W" To avoid shock hazard, injury, and meter damage, do not apply more than 1000V between any meter input jack and earth ground. Circuit under test must be protected by a 20A fuse or circuit breaker.

Application:

Use the **A⎓** *Total Effective Voltage feature when measuring an input with both AC and DC components. For example, outputs from poorly filtered power supplies or voltages to copier heating elements.*

Measuring True RMS Voltage (AC coupled) Models 2020 and 2030 only

1. Select AC Volts **V∼**.
2. Attach the probe tips to voltage source. Voltage reading that appears will be True RMS value of AC input source. See Section III page 14 for an explanation of True RMS.

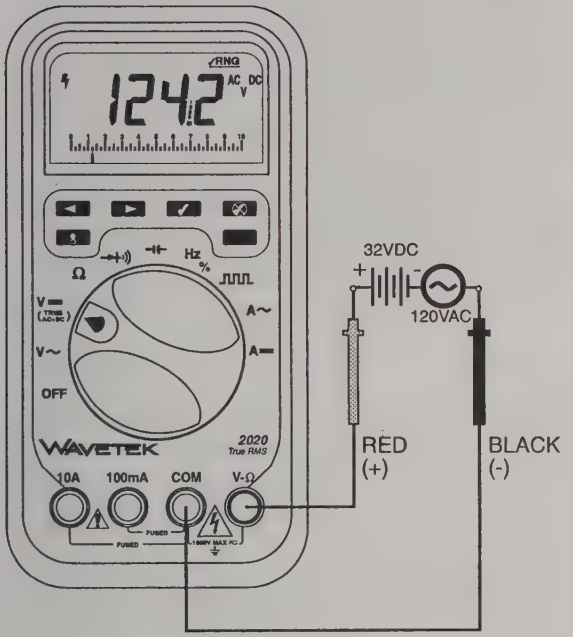


Figure 8: True RMS (AC + DC Coupling) Voltage Measurements

Note:

Both the 2020 and the 2030 are capable of behaving as average responding meters. In AC Volts, depress the Backlight and second function buttons simultaneously so that the % annunciator appears. This indicates the true RMS converter has been removed from the circuit and that the meter is now average responding. Use this feature to check for harmonics by comparing average responding readings with True RMS readings. Depress both buttons again to cancel this feature.

Measuring True RMS Voltage (AC coupled) – continued

Note:
Use the V~ Total Effective AC Voltage function when the measurement of the DC component is not desired.

Application:
Use the V~ Total Effective AC Voltage function when measuring voltages with harmonics. Harmonics are multiples of the basic frequency and can cause circuit breakers to trip, overloaded neutrals, and overheat transformers and generators. Typical equipment that may generate harmonics are variable speed motor drives, switching power supplies of PCs and high frequency fluorescent lighting ballasts, or other non-linear loads.

Measuring Resistance

1. Select Resistance (Ω).
2. OPEN will appear in the display when in the autoranging mode, "OL" will appear in the Range Lock mode. This is normal when measuring resistance, and when the leads are open (resistance is infinite).
3. Confirm proper operation by shorting the test probe leads. The display should zero out (less the test lead resistance), and the Bar Graph pointer should move to the same relative position.
4. Attach the probe tips to the resistance as shown in the following figure. The LCD will show dashes until the reading has stabilized. The resistance will then appear in the display, as will the appropriate Unit Annunciator. The Bar Graph indicator will move to the appropriate position on the Bar Graph scale.

"P" **Discharge any capacitors in the circuit before taking a resistance measurement. Any voltage present will cause incorrect readings or the "OL" or "Open" prompt to be displayed.**

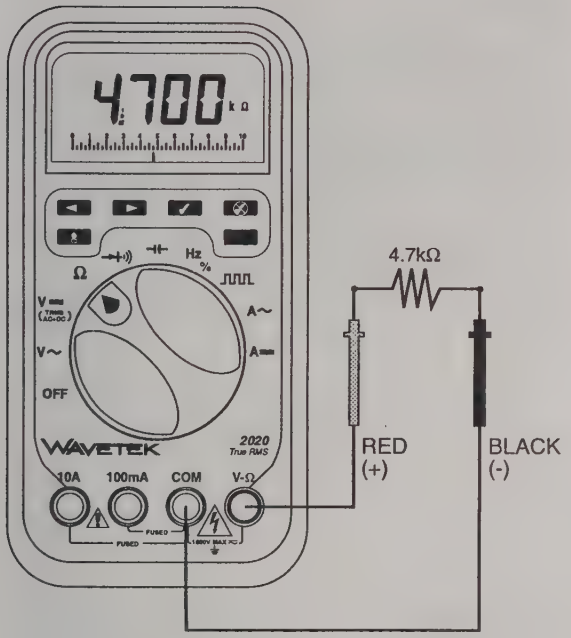


Figure 9: Resistance Measurements

Note:

When measuring very low resistances, less than 10 ohms, it is recommended to use REL and eliminate the test lead resistance. The Series 2000 DMMs are capable of testing in-circuit resistance without the removal of diodes and transistors. DMM voltages used for resistance measurements are low enough not to forward bias silicon diodes or transistor junctions. Refer to specifications for voltages and ranges.

Diode/Continuity Test

1. Select Diode/Continuity →|·)).
2. OPEN will appear in the display. This is normal when testing diodes or for continuity.
3. Attach the probe tips to the diode as shown in the following figure, selecting either the forward or reverse bias configuration. The Bar Graph indicator will move to the appropriate position on the Bar Graph scale.
4. At approximately .8 volts, the meter will generate a short tone indicating a good diode.
5. When checking reverse bias, the display will show "OPEN", indicating an open circuit (a good diode). There is no tone.
6. If the diode is shorted (or when checking electrical continuity), the meter will generate a constant tone. This occurs if the resistive value falls below 100 ohms.

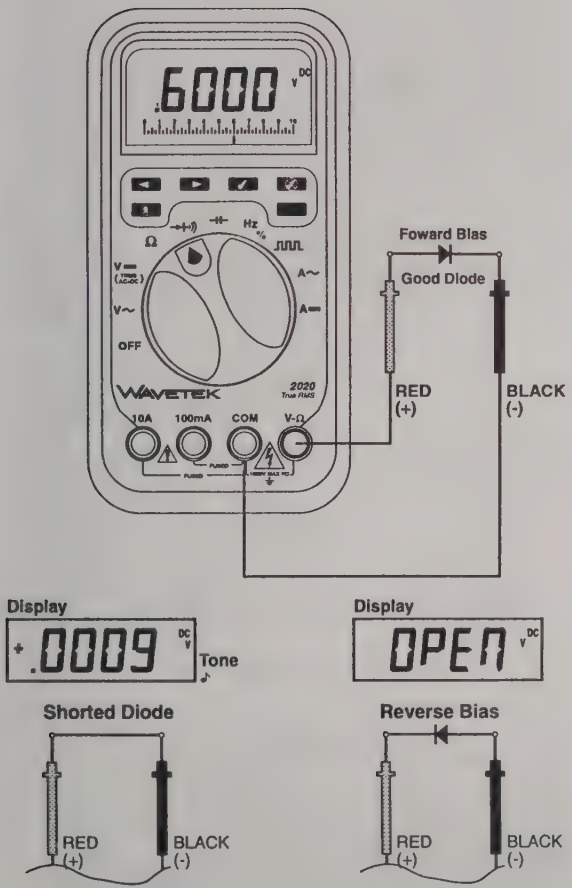


Figure 10: Diode/Continuity Measurements

Measuring Capacitance

1. Select Capacitance ⊣⊢.
2. Discharge the capacitor by shorting the capacitor leads together.

> **Note:**
> Large valve capacitors should be discharged through an appropriate resistance load.

3. Attach the probe tips to the capacitance as shown in the following figure. Holding the probes with your hands may change the capacitance in circuit and generate a false reading. The LCD will display the value and the appropriate Unit Annunciator.

No Input	LCD Displays	0.0 nF
Leads Shorted or Capacitor too Large for Range	LCD Displays	OL mF
When Ranging	LCD Displays	- - - -
Capacitor Too Small for Range	LCD Displays	OPEN

Figure 11: Display Information

> **Note:**
> The Fault Finder ♪, if selected, will change pitch with the charge and discharge of the capacitor.
> For capacitance measurements only, decimal positioning is correct but corresponding numerical value does not indicate the correct range. See Section VII, *Specifications*, for available ranges.
> The Bar Graph may be invoked by depressing the ◄ button while turning the knob to capacitance from ohms. The Bar Graph will then provide a visual display of the charging/discharging on the capacitor being measured.

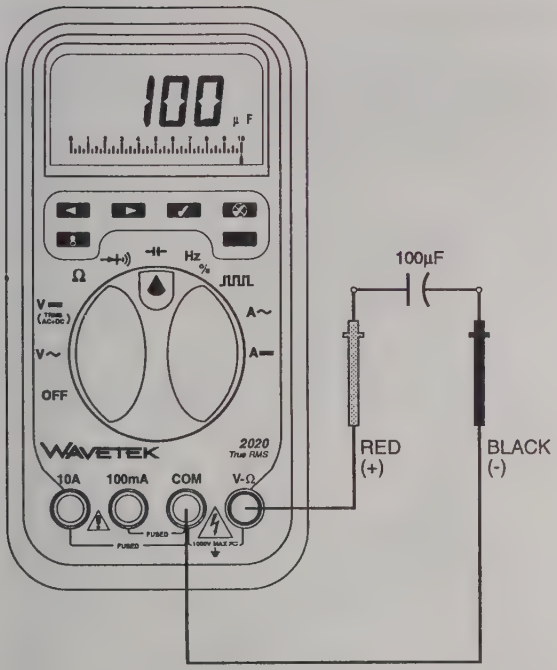


Figure 12: Capacitance Measurements

Measuring Frequency/Duty Cycle

1. Select Frequency **Hz%** .
2. Attach the probe tips to the signal source as shown in the following figure. The LCD will display the value along with the appropriate Unit Annunciator. The Bar Graph is not available for this function.
3. To measure duty cycle simply press the 2nd Function button. Duty cycle will read out in %.

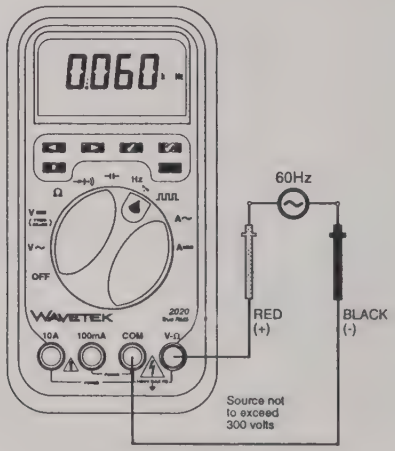


Figure 13: Frequency Measurements

Note:

Pulse width measurements can be calculated from the measured frequency and duty cycle. Use the following equation:

$$\text{Pulse Width} = \frac{\text{\% Duty Cycle}/100}{\text{Frequency}}$$

Standard gate time of the frequency counter is one second. A faster gate time of 48 milliseconds is possible by simultaneously pressing the left and right menu keys ◄ ►. The frequency counter will remain in this mode until both keys are pressed again or the meter is turned off.

Pulse Detection (Logic, DCV)

1. Select Pulse Detection ⎍⎍⎍.
2. Attach the probe tips to the signal source as shown in the following figure. The LCD will display the DC voltage of the input and a short tone will occur for each positive transition. Above 20 pulses per second, the tone will become continuous.

Note:
Only positive going pulses are indicated, so for best results connect the common lead to circuit ground.

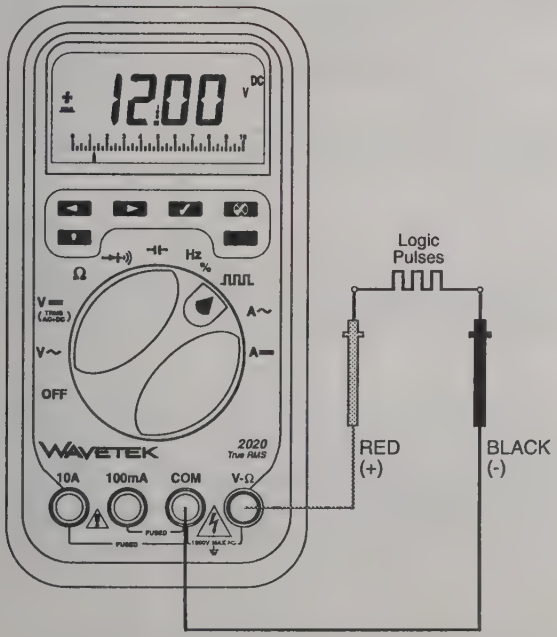


Figure 14: Pulse Detection (Logic) Measurements

Measuring AC Current

1. Select AC Current A~.
2. Disconnect the current source.
3. Break the circuit at the point where the current is to be measured. The voltage at the test point must not exceed 600V with respect to ground.
4. As shown in the following figure, insert the meter in series with the circuit and connect the red lead to the 100mA Jack for input currents up to 100mA, or to the 10A Jack for input currents up to 10A.
5. Apply current to load.
6. The Bar Graph indicator will move to the appropriate value on the Bar Graph scale.

Measuring True RMS AC Current (AC Coupled) Models 2020 and 2030 only

1. Follow above steps 1 through 6.
2. Current reading that appears will be True RMS value of AC current source. See Section III page 14 for an explanation of True RMS Current.

Note:

Models 2020 and 2030 are True RMS meters and will provide accurate wide bandwidth AC current measurements. Total Effective AC current is required when measuring nonsinusoidal waveforms or waveforms containing harmonics from nonlinear loads.

Both the 2020 and the 2030 are capable of behaving like average responding meters. In ACA, depress the Backlight and second function buttons simultaneously so that the % annunciator appears. This indicates the true RMS converter has been removed from the circuit and that the meter is now average responding. Use this feature to check for harmonics. Depress both buttons again to cancel this feature.

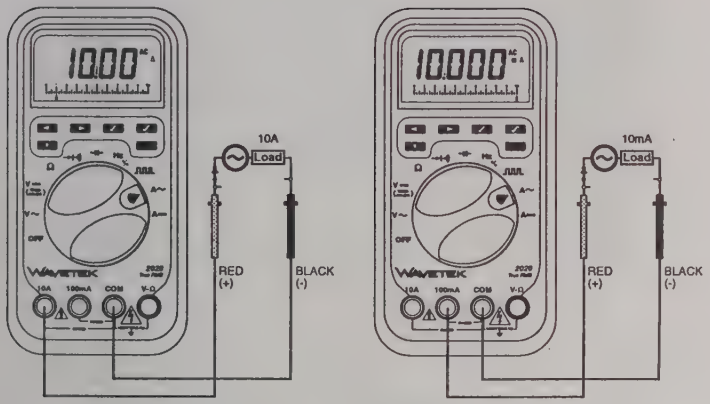


Figure 15: AC Current Measurements

"W" **To avoid meter damage when using the 10A range: do not exceed 10A (continuous), do not measure current levels from 10A to 20A (maximum) for any longer than 30 seconds. Allow five minutes for cool-down before continuing.**

When measuring a current transformer, use the 10A range to prevent damage from potentially high voltages.

"P" **The meter displays a function error code "FErr" if a test lead is inserted into the 10A Jack when the meter is set for any function other than AC or DC current. Also, if "FErr" is displayed during normal operation, factory service may be required.**

Measuring DC Current

1. Select DC Current A⎓.
2. Disconnect the current source.
3. Break the circuit at the point where the current is to be measured. The test point must not exceed 600V with respect to ground.
4. As shown in the following figure, insert the meter in series with the circuit and connect the red lead to the 100mA Jack for input currents up to 100mA, or 10A Jack for input currents up to 10A.
5. Apply current to load.
6. The Bar Graph indicator will move to the appropriate value on the Bar Graph scale.

Measuring True RMS (AC on DC) Current

Note:
Models 2020 and 2030 provide the Total Effective Current (AC + DC) in the same manner as Total Effective Voltage, by depressing the second Function button. When only the DC current annunciator is on only DC current is being measured and displayed.

1. Measure the AC Component. Remember AC Current Range.
2. Select DC Current.
3. Press the second function button to make True RMS. The AC and DC annunciators will both turn on.
4. Press the ✓ select button until the DC Current Range is the same as the AC Current measured in step 1.
5. The LCD will show dashes until the reading has stabilized: the Bar Graph will then indicate the AC components of the input signal.
6. If the current is too high, "OL" will appear in the display.

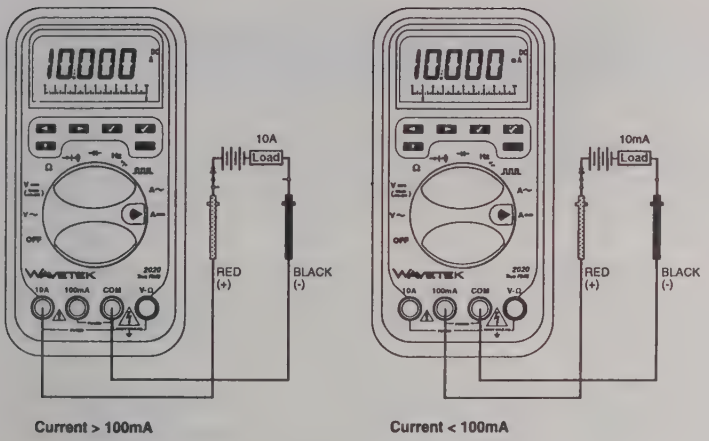


Figure 16: DC Current Measurement Hookup

"W" **To avoid meter damage when using the 10A range: do not exceed 10A (continuous), do not measure current levels from 10A to 20A (maximum) for any longer than 30 seconds. Allow five minutes for cool-down before continuing.**

When measuring a current transformer, use the 10A range to prevent damage from potentially high voltages.

"P" **The meter displays a function error code "FErr" if a test lead is inserted into the 10A Jack when the meter is set for any function other than AC or DC current. Also, if "FErr" is displayed during normal operation, factory service may be required.**

True RMS Voltage and Current Measurements

Models 2020 and 2030 utilize an RMS converter chip that automatically calculates the total RMS value of an input signal. The design of this chip is such that low level input signals, less than 5% of range, are not as accurate as those greater than 5% of range. Also, the speed of response is somewhat slower. To demonstrate this with a 2020 or 2030, insert the test leads in the 10 Amp and common jacks. Select AC Amps. Short the test leads and observe the number of counts on the display. Now remove the RMS converter (see note on page 36) and observe as the number of counts on the display decrease because the RMS converter is no longer in the circuit.

Most True RMS digital multimeters make use of this identical chip and are also subject to higher counts and less accuracy with low level inputs. Only the Wavetek 2020 and 2030 allow the operator to "electronically" remove the RMS converter and actually measure the affects of harmonics.

In order to speed up meter response with low inputs, experiment by removing the RMS converter or by range locking the meter in the next highest range. With 1000:1 current transformer style current clamps it is advisable to first start in the 10 Amp jack then utilize the 100mA input jack with currents measured less than 100 Amps.

Section V Special Features

The Series 2000 multimeters have a number of operator-selectable special features that increase the flexibility of the device. The features are; Range Lock, Probe Hold™, Auto Relative Mode, Auto Min Max™, Peak Hold, and Fault Finder™.

Range Lock (RNG)

Range Lock allows the operator to "lock" the meter scale into the currently displayed range. Range Lock is available for the following functions:

V~	V⎓	Ω	→+•))	⊣⊢	Hz %	⎍⎍⎍	A~	A⎓
✓	✓	✓		✓		✓	✓	✓

Table 7: Range Lock Feature

To use the Range Lock feature:

1. Select desired function.
2. Engage MENU with ◄ or ►.
3. Move cursor √___ to RNG.
4. Depress ✓ to select √RNG.
5. Continue to Press ✓ to select desired range. Meter is ready for use.

Note:
The MENU will continue to flash for several seconds and then turn off. Other MENU selections may be made at this time.

6. To deselect √RNG, press ⊘ when the cursor is on √RNG. MENU will continue to flash for several seconds and then turn off. Or, press ⊘ twice to delete all features.

"P" **If the input exceeds the selected range, the "OL" prompt will be displayed.**

Range Lock Application:

Speed up power supply measurements when troubleshooting a circuit board by Range Locking the meter in the proper range. Also consider using the Fault Finder™ to "hear" voltage variations.

Probe Hold™ (HLD)

Probe Hold™ allows the operator to take a measurement and then remove the probes from the circuit while the measured value remains displayed for later viewing. Probe Hold™ is available for the following functions:

V~	V⎓	Ω	→+•))	⊣⊢	Hz %	⎍⎍⎍	A~	A⎓
✓	✓	✓	✓	*	*	✓	✓	✓

Table 8: Probe Hold™ Feature

To use Probe Hold™:

1. Select desired function.
2. Engage MENU with ◄ or ►.
3. Move cursor √___ to HLD.
4. Press ✓ to select √HLD. Meter is ready for use. MENU will continue to flash for several seconds and then turn off.
5. Apply input to meter. If input is stable the meter will issue a tone indicating the reading is recording and the probes can be removed.

The measurement will remain displayed until:

- a new stable input is measured
- an overload occurs
- the Function Selector Switch is changed
- the meter is powered off
- Auto Power Down turns the meter off

6. To deselect √HLD, press ✓ when the cursor is on HLD. MENU will continue to flash for several seconds and then turn off. Or, press ✓ twice to delete all features.

*In the capacitance and frequency functions, Probe Hold™ is only capable of "holding" the displayed value when ✓ is depressed and does not automatically update with changing inputs.

Note:

To suppress false triggering, the minimum range for Voltage is preset to the 10 volt range and any measurement less than 800 counts is considered to be zero and will not be held. In order to select ranges less than 10 volts, press ✓ when cursor is on HLD or RNG and the range will change.

Probe Hold Application:

Use Probe Hold anytime high voltage is present and it is critical to keep your eyes on your work so that you do not accidentally touch the high voltage source.

Relative Mode (REL)

Relative Mode allows the operator to measure values with respect to a reference value other than zero. Relative Mode operates with all functions:

V~	V⎓	Ω	→+·))	⊣⊢	Hz %	⎍⎍⎍	A~	A⎓
✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 9: Relative Mode Feature

1. Select desired function.
2. Apply input signal to meter.
3. Engage MENU with ◄ or ►.
4. Move cursor √___ to REL.
5. Press ✓ to select √REL. Meter is ready for use. MENU will continue to flash for several seconds and then turn off. Display will show a near-zero value and the input level is now the baseline or reference value. All subsequent measurements will be relative to the baseline value. The Relative Mode remains in the autoranging mode for best resolution. Please note the meter will down range to the lowest range and may indicate a number of counts.
   For example, if the reference voltage is set to +100V and the meter probes are placed across a +90V source, a value of -10V will be displayed. A new reference value can be selected by applying a new input value and pressing ⊘, then ✓, with cursor on √REL. The meter will reinitialize on the new input value.
6. To deselect √REL, press ⊘ when the cursor is on REL. MENU will continue to flash for several seconds and then turn off. Or, press ⊘ twice to delete all features.

Relative Mode Application:
When inspecting multiple batteries for UPS systems "REL" on the ideal voltage and verify subsequent batteries are within allowable tolerances.

Auto Min Max™ (MX-MN AV)

Auto Min Max allows the operator to measure and record the minimum, maximum, and running average of both positive and negative polarity input signals. Auto Min Max works with all available functions.

V~	V⎓	Ω	→+·))	⊣⊢	Hz %	⎍⎍⎍	A~	A⎓
✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 10: Auto Min Max Feature

To use the Auto Min Max feature:

1. Select desired function.
2. Apply input to meter.
3. Engage MENU with ◄ or ►.
4. Move cursor √___ to MX-MN AV.
5. Press ✓ to select √MX-MN AV. Recording of the input signal will begin immediately. MENU will continue to flash for several seconds and then turn off.
6 Press ✓ to view values, MX, MN, MX-MN, AV.
7. To deselect √MX-MN AV, press ✓ when the cursor is on MX-MN AV. MENU will continue to flash for several seconds and then turn off. Or, press ✓ twice to delete all features.

Once the Auto Min Max feature is enabled, the meter will continue to function normally, displaying real time data while recording the minimum and maximum levels. The recorded minimum and maximum value will be updated only when the input exceeds the previous value. The meter will issue a tone each time a recorded value is updated. To reset Auto Min Max deselect the feature and then reselect it.

Auto Min Max provides autoranging throughout the entire input range, unless meter is manually range locked. This assures the greatest possible level of signal resolution.

Two methods of averaging can be used: "Rolling", which takes an average of last 60 readings; and "True", which takes the average of all readings. The Auto Min Max AVG is initialized in the "True" method.

To select between the two:

1. Select AVG,√_____AV_ .
2. Depress ◄ ► simultaneously. ROLL, "roll" will appear and the subsequent average reading will be based on the Rolling method.
3. Depress ◄ ► again and TRUE, "trUE" will be displayed. The subsequent average will be based on the true method.

Auto Min Max Application:

When monitoring power lines or power supplies for voltage swings Auto Min Max can record the fluctuations. It will also measure and record devices under test while unattended.

"P" While in the Auto Min Max mode, the meter disables the Auto-Power Down feature. This allows for extended monitoring of the input level, but will continue to drain the battery. For best results, start with a fresh battery before using Auto Min Max over a long time period.

Display indicates	Value
MN	Minimum Recorded Value
MX	Maximum Recorded Value
MX-MN	Delta of MX, MN
AV	Input Average
MX-MN AV	Current input value

Table 11: Auto Min Max Annunciator Definitions

Peak Hold (PK)

The Peak Hold feature (PK) is a method of reading voltage and current inputs as short as 1ms. Peak Hold is available for the following functions:

V~	V⎓	Ω	→+•))	⊣⊢	Hz %	⎍⎍⎍	A~	A⎓
✓	✓						✓	✓

Table 12: Peak Feature

To use the Peak feature:

1. Select desired function.
2. Apply input signal to meter.
3. Engage MENU with ◄ or ►.
4. Move cursor √___ to PK.
5. Press ✓ to select √PK. Measurement MAX (positive) of peak values begins immediately.
6. To measure peak Min (negative) values move cursor to MX-MN AV. Press ✓ so MN appears. Measurement of Peak MIN values begin immediately.
7. To deselect √PK, press ✓ when the cursor is on PK. MENU will continue to flash for several seconds and then turn off. Or, press ✓ twice to delete all features.
8. Press the second function button to zero, "ZERO," Peak Hold to accept new peak readings.

Note:

The Peak Hold function Range Locks the meter and it may be necessary to up the range of the meter to accommodate all possible input values. To up the range, invoke RNG and press ✓ for appropriate range. Two tones indicate a new peak value has been inputed. Peak Hold also disables the Auto-Power Down feature allowing for extended input monitoring.

In low ranges, Peak Hold may update on noise. This is especially true if the test leads are open or in a circuit. To ensure proper zeroing, select correct range for your measurements and press the second function button while the leads are shorted.

Peak Hold Application:

Peak Hold is very useful for transient monitoring on power lines, measuring motor in-rush current and momentary voltage spikes.

Fault Finder™ ♪

The Fault Finder™ is a feature unique to Wavetek multimeters. When enabled, the multimeter will issue a tone whose pitch changes according to the value being displayed. For example, a 5 volt reading will have a lower pitch than a 9 volt reading. The Fault Finder™ works with the following functions:

V~	V⎓	Ω	→+•))	⊣⊢	Hz %	⎍⎍⎍	A~	A⎓
✓	✓	✓		✓			✓	✓

Table 13: Fault Finder™ Feature

To use the Fault Finder™ feature:

1. Select desired function.
2. Engage MENU with ◄ or ►.
3. Move √___ to ♪ .
4. Press ✓ to select √♪. The tone will begin immediately and will change rapidly with varying input signals. The MENU will continue to flash for several seconds and then turn off.
5. To deselect √♪ press ⊗ when the cursor is on ♪. MENU will continue to flash for several seconds and then turn off. Or, press ⊗ twice to delete all features.

Fault Finder™ Application:

Detection of an intermittent wire or circuit board trace. Place meter in resistance function and invoke the Fault Finder™. The meter will produce a slow click for a short and no sound for an open circuit. Should an intermittent occur the meter will produce a scratchy sound for short to open transition and a shrill sound for an open to short transition.

Due to the very fast response time of the Fault Finder™, peaking and nulling RF circuits becomes easy. Also, for fast power supply troubleshooting, the Fault Finder™ easily distinguishes between +12VDC, +5VDC and ground without you ever looking at the display.

Section VI Maintenance

This section covers battery and fuse replacement and provides an assembly parts list. For calibration and service information, refer to the Series 2000 Service Manual, P/N 1000-0769-00.

> **"W" To avoid electrical shock, disconnect the meter from all voltage sources before the case is opened. Close the case before returning the meter to service.**

Battery Replacement

When the battery symbol on the display is on, less than 20 hours of battery life remains (See Figure 16).

1. Turn the meter OFF and disconnect it from any circuit.
2. Remove the three Phillips-head screws as shown in following figure.
3. Disconnect and remove battery. Replace with a NEDA-type MN1604 9 volt alkaline battery or equivalent.
4. Route battery leads so they do not interfere with case, circuit board or battery.
5. Replace case back. Ensure gasket is seated correctly and case snaps at LCD end are in place. Reinstall screws.

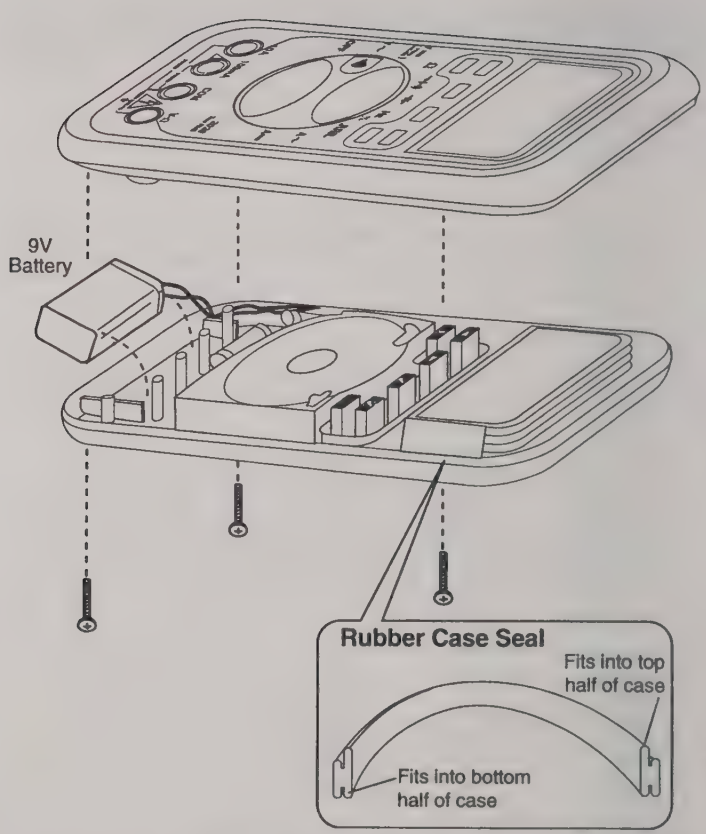


Figure 17: Battery Replacement

Note:

Should the case seal become separated from the meter when disassembling for battery or fuse replacement, be sure the seal is replaced correctly. The seal should be replaced on the bottom case half with the direction of the seal as shown here. Top case half will fit into groove of seal when meter is reclosed.

Fuse Replacement

The Series 2000 meter uses an input protection fuse for the 100mA and 10A inputs. To ensure safe operation, replace the fuses with the correct part number or equivalent. See the following figure.

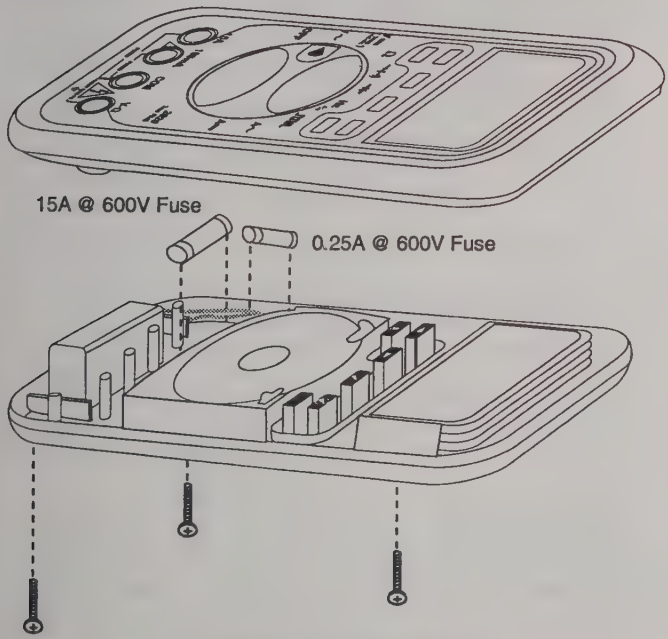


Figure 18: Fuse Replacement

Fuses can be tested without removing them from the meter.

1. Select the resistance function.
2. Measure from the V-Ω jack to the right side of the split ring in the 10A jack. A good fuse will read less than 0.4 ohms.
3. Measure the input jack in the 100mA jack. A good fuse will read less than 15 ohms.
4. If either fuse reads OL, visually check the fuse and replace it if necessary.

1. Turn the meter OFF and disconnect it from any circuit.
2. Remove the case back, as shown.
3. Disconnect and remove the battery.
4. Remove the electronics assembly from the case.
5. Replace any blown fuses. For the 10A input large fuse use 15A @ 600V; Littel Fuse use part number KLK-15, Bussman part number KTK-15 or Wavetek part number 3000-400-214. For the 100mA input small fuse use 0.25A @ 600V: Wavetek part number FP360.
6. Route battery leads so they do not interfere with case, circuit board or battery.
7. Replace case back. Ensure gasket is seated correctly and case snaps at LCD end are in place. Reinstall screws. Refer to "Rubber Case Seal" note on pg. 49.

Assembly Parts List

When servicing the meter, it is recommended that only Wavetek replacement parts be used. Replacement parts for the meter are listed in the following table.

Parts Description	Part Number
Battery (Alkaline, 9VDC)	NEDA 1604 A
Case, Front	3000-426-391
Case, Rear	3000-420-382
Holster	1000-0171-01B
*Service Manual	1000-0184-01B
Screw, Case 4-40 x 7/8"	3000-450-247
Test, Probe Set (R+B)	3000-370-282

* The Service Manual is not included with your meter and may be ordered separately from any factory service center.

Table 14: Assembly Parts List

Optional Accessories

The following accessories can be ordered for use with the Series 2000 multimeter.

Test Lead Sets

AL244	Alligator clips for TL244 (one red, one black).
DL243B	Deluxe Kit. Includes silicone rubber insulated lead wires, push-on test probes, insulated alligator clips, spade lugs, and a nylon carrying case.
TL244	Heavy duty electricians Ever Sharp™ test leads.
TL245	Standard replacement test leads.
TL246B	Heavy duty insulated alligator clips with 40" silicone leads.
TL247	Tweezer probe for measuring very small Surface Mount Devices (SMD) such as capacitors and resistors.
TL251	Heavy duty, extra large alligator clips with 48" leads.
DL248B	Deluxe Kit. Includes silicone rubber insulated lead wires, push-on test probes, insulated alligator clips, spring-hooks, a two-inch insulated needle tip, spade lugs, and a nylon carrying case.
DL249	Surface Mount Devices Kit. Includes silicone rubber insulated lead wires, push-on test probes, one black insulated alligator clip, spring-hooks, a two-inch insulated needle tip, SMD tweezer probe (TL247), two SOIC clips (16 pin & 28 pin), and a nylon carrying case.

Table 15: Test Lead Accessories

Carrying Cases/Holsters

VC221	Reinforced, fabric lined vinyl case. Fits standard test leads and meter with holster.
VC231	Reinforced, fabric lined vinyl case. Fits standard test leads, and meter without holster.
H221	Gray Holster.
H221Y	Yellow Holster.

Table 16: Carrying Cases and Holsters

Probes/Clamps

HV231-10	40kVDC high voltage probe.
RF241	200MHz RF probe.
CT231	2A to 150A AC clamp-on current probe. (40Hz to 500Hz)
CT232	1A to 1000A AC clamp-on current probe. (40Hz to 10kHz)
CT233	1A to 600A DC/AC clamp-on current probe. (0 to 400Hz)
CT234A	4A to 400A AC clamp-on current probe. (40Hz to 1kHz)
CT236	10A to 500A AC clamp-on current probe. (40Hz to 1kHz, mV output)
TC253	Temperature converter (probe not included).
TP254	General purpose Type K thermocouple probe. TC253 is also required.
TP255	Type K thermocouple probe with beaded end. TC253 is also required.

Table 17: Optional Accessories

Section VII Specifications

This section provides physical, mechanical, and environmental specifications for the Wavetek 2010, 2020, and 2030 multimeters. Specifications are subject to change without notice.

General Specifications

Display:	LCD, quadriplex, 19999 count; annunciators, menu features and bar graph.
Update:	Digits, 2/second Bar graph, 20/second
Battery:	9 volt, Alkaline; NEDA 1604 A
Battery Drain:	2.2mA typical (DCV, no input)
Battery Life:	200 hours typical (alkaline)
Power Off Mode:	< 10µA
Low Battery Indicator:	Battery voltage < = 7.5V; 20 hours left
Low battery CUT-OFF:	Battery voltage < = 6.6V
Maximum Common Mode Voltage:	1000 VDC or Peak AC

Physical (Not including holster)

Height:	175mm (7.5 in.)
Width:	90mm (3.5 in.)
Depth:	34mm (1.30 in.)
Weight:	568g (20 oz.)

Mechanical

Shock and Vibration:	MIL-T-28800, class II
Case Material:	Flame retardant, high-impact thermoplastic

Environmental

Operating Temperature:	0° to 50° C
Relative Humidity:	0 to 80%
Storage Temperature:	-40° to 70° C
Relative Humidity:	0 to 95% (battery removed)
Temperature Coefficient:	<0.1 x (specified accuracy) per degree C (0° to 20° C, 30° to 55° C)

Safety

Designed to UL1244, CSA 22.2 No.231
Certified to IEC1010, part I
Installation CAT. III (polution degree II)

Calibration

Accuracy specifications guaranteed for one year.

Transient Protection	AC/DC Voltage Ranges: 6kV (V-Ω input jacks shunted by 250pF capacitor. 1.2 x 50µs per IEEE-587, CAT-B.

Start Up Sequence

A. The meter will first show all segments of the LCD ON. This can be extended by pressing the Second Function button.
B. Battery cutoff test: "bAtt" will show in the display. The bar graph points at the approximate positive power supply voltage. Nominal cutoff point for the positive power supply voltage is 5.25 on the scale. If power supply voltage is lower than 5.25, meter will indicate "Lobt" (Low Battery) and shut itself off.
C. The unit will now go to the appropriate display for the function selected.

Display Update Rate

Numerals:	Numerals: 2/second
Bar Graph:	Bar Graph: 20/second

DC VOLTS

Ranges	Resolution	Accuracy 2010, 2020	(% rdg ± digit) 2030
100.00mV	0.01mV	0.25% ± 2	0.10% ± 2
1000.0mV	0.1mV	0.25% ± 2	0.10% ± 2
10.000V	1.0mV	0.25% ± 2	0.10% ± 2
100.00V	10mV	0.25% ± 2	0.10% ± 2
1000.0V	100mV	0.25% ± 2	0.10% ± 2

Response:	< 2 sec, manual or autoranging
Input impedance:	10 Meg ohms
Display Bar Graph:	Indicates percent of range
Normal Mode Rejection Ratio:	> 60dB at 50 and 60Hz
Common Mode Rejection Ratio:	> 120dB up to 1000VDC (< = 1k unbalance).
Overload Protection:	1000VDC
Overload Indication:	"OL" indicates a range overload. In the 1000V range, and the input > 1020.9VDC, there is also a continuous warning tone.
Lethal Voltage Indication:	Lightning bolt in LCD and double beep when the input exceeds 25V.

AC VOLTS

Input is from 5% to full-scale on each range

Ranges	Resolution	Frequency	Accuracy (% rdg ± digit), Crest Factor < 1.5)
100.00mV	0.01mV	45 to 400Hz	2.0% ± 8 digit
1000.0mV	0.1mV	45 to 2kHz	2.0% ± 8 digit
10.000V	1.0mV	45 to 2kHz	2.0% ± 8 digit
100.00V	10.0mV	45 to 2kHz	2.0% ± 8 digit
1000.0V	100mV	45 to 2kHz	2.0% ± 8 digit

Response:	< 3 sec Manual or autoranging
Frequency Response:	3dB > 10kHz
Input Impedance:	10 Meg ohms shunted by < 100pF
Display Bar Graph:	Indicates percent of range
Conversion Type:	2020, 2030; True RMS AC coupled and Average Responding, 2010; Average Responding
Crest Factor for True RMS (peak/RMS ratio):	1:1 through 5:1
Overload Protection:	<10Hz, 400VRMS; >10Hz, 1000VRMS
Overload Indication:	"OL" indicates a range overload. In the 1000V range, and the input > 1020.9VAC, there is also a continuous warning tone.

DC CURRENT

Range	Resolution	Accuracy (% rdg ± digit) 2010,2020	2030	Voltage Burden
1000.0µA	0.1µA	1.0% + 2	0.50% ± 2	15mV/mA
10.000mA	0.001mA	0.5% + 1	0.35% ± 1	15mV/mA
100.00mA	0.01mA	0.5% + 1	0.35% ± 1	15mV/mA
1000.0mA	.01mA	1.0% + 2	0.50% ± 1	40mV/A
10.000A	1.0mA	1.0% + 1	1.00% ± 1	40mV/A
20.00A	10mA	1.0% + 1	1.00% ± 1	40mV/A

Response:	< 3 sec manual or autoranging	
Display Bar Graph:	Indicates percent of range	
Overload Protection:	mA	.25A, 600V fuse; 1000A Interrupt Rating
	A	15A/600V fuse; 100,000A Interrupt Rating
Amps Capability:	10A	continuous
	20A	for 30 seconds
Over-Range Indication:	"OL"	Input > 102.09mA has a continuous tone
		Input > 20.49A has a continuous tone

AC CURRENT

Input is from 5% to full-scale on each range.

Range	Resolution	Frequency	Accuracy (Crest Factor <= 1.5)	Voltage Burden
1000.0µA	0.1µA	45Hz - 1kHz	1.7%±8 digits	15mV/mA
10.000mA	0.001mA	45Hz - 1kHz	1.7%±8 digits	15mV/mA
100.00mA	0.01mA	45Hz - 1kHz	1.7%±5 digits	15mV/mA
1000.0mA	0.1mA	45Hz - 1kHz	1.7%±5 digits	40mV/A
10.000A	1.0mA	45Hz - 1kHz	1.7%±3 digits	40mV/A
20.00A	10mA	45Hz - 1kHz	1.7%±3 digits	40mV/A

Response:	< 3 sec manual or autoranging
Frequency Response:	3dB > 10kHz
Conversion Type:	True RMS AC coupled (2020, 2030); Average Responding (2010)
Crest Factor: (Peak/RMS Ratio)	1:1 through 5:1
Display Bar Graph:	Indicates percent of range
Overload Protection:	mA .25A, 600V fuse; 1000A Interrupt Rating A 15A/600V fuse; 100,000A Interrupt Rating
Amps Capability:	10A continuous 20A for 30 seconds
Over-Range Indication:	"OL" Input > 102.09mA has a continuous tone Input > 20.49A has a continuous tone

RESISTANCE

Range	Resolution ohms	Accuracy (% rdg ± digit) 2010, 2020	2030	Test Current (Max)	Test Voltage (Max)
100.00	0.01	0.7%±4 digits	0.5% ± 4	1.0mA	100mV
1000.0	0.1	0.5%±4 digits	0.3% ± 4	0.1mA	100mV
10.000k	1.0	0.5%±4 digits	0.3% ± 4	10µA	100mV
100.00k	10	0.5%±4 digits	0.3% ± 4	1.0µA	100mV
1000.0k	100	0.5%±4 digits	0.3% ± 4	0.1µA	100mV
10.000M	1.0k	1.5%±4 digits	0.7% ± 4	0.1µA	1.0V
20.00M	10k	2.0%±4 digits	1.2% ± 4	0.1µA	2.0V

Response: < 2 sec below 1 Meg
<3 sec above 1 Meg
manual or autoranging

Display Bar Graph: Indicates percent of range up to 10MΩ

Maximum Open Circuit Voltage: 6.5V

Over-Range Indication: "OPEN" in display when in autorange mode
"OL" in display when in range lock mode

Overload Protection: 500VRMS

PULSE DETECTOR

Indication:	Positive transitions detected emits a tone
Tone Length:	Approximately 50mS. If transition >20Hz rate, tone is continuous.
Detector:	AC coupled
Logic Levels:	TTL, CMOS
Threshold:	2.6 volts
Input Impedance:	10MΩ shunted by 150pF
Display Bar Graph:	Indicates percent of range (for DC volts)
Pulse Width (min):	50nS
Pulse Rise Time (max):	10nS
Pulse Rep Rate (max):	1MPPS

DIODE/CONTINUITY

Range	Resolution	Accuracy (% rdg ± digit)	Short Circuit Current (Max.)	Open Circuit Voltage (Max.)
2.0000V	0.2mV	1.0%±5 digits	1.0mA	5.5V

Display Response:	< 2 second
Continuity Response Time:	< 50mSec
Continuity Threshold:	< 200 millivolts
Display Bar Graph:	Indicates percent of range to one volt only
Continuity Indication:	Continuous tone
Open Circuit Indication:	"OPEN" in display
Overload Protection:	500VRMS

"W" The Diode/Continuity range is not to be used to measure explosive bolts or squibs.

CAPACITANCE

Range	Resolution	Accuracy (% rdg ± digit)
20.0nF	0.1nF	2.0% ± 3 digits
200nF	1nF	2.0% ± 3 digits
2.00µF	0.01µF	2.0% ± 2 digits
20.0µF	0.1µF	2.0% ± 2 digits
200µF	1µF	3.0% ± 3 digits
2.00mF	10µF	3.0% ± 8 digits

Response: After the first update
< 1 sec below 20µF
< 2 sec below 200µF
< 25 sec to 2mF

Manual or Autoranging

Maximum Open Circuit Voltage: 6.5V

Over-Range Indication: "OL" in display in autorange for a capacitor too large or the leads are shorted together.

"OL" in display in range lock for a capacitor too large for the range or the leads are shorted together.

"OPEN" in display in range lock for a capacitor that is less than ten percent of the full-scale range (except the 20nF range, which shows to zero).

Overload Protection: 500VRMS

FREQUENCY

Range	Resolution	Accuracy (% rdg ± digit)	Sensitivity
19.999kHz	1.0Hz	0.1% ± 2 digits	100mV
199.99kHz	10Hz	0.1% ± 2 digits	100mV
1.9999MHz	100Hz	0.1% ± 2 digits	1.0V

Response: <1.5 sec

Input Impedance: 51kΩ into diodes, AC Coupled

Display Bar Graph: Not present

Overload Protection: 300VRMS

SECOND FUNCTIONS (2nd function button)

TRMS

True RMS:	DC and AC volts
Specification:	Same as AC volts (including frequency range)
DC volts:	2.0% on all ranges. If a high DC voltage is present, the unit will have to be in range lock to get the correct reading.
Response:	< 3 sec manual or autoranging
Input impedance:	10 Meg ohms shunted by < 100 pF
Display Bar Graph:	Indicates percent of range (AC component only).
Conversion Type:	True RMS
Crest Factor (peak/RMS ratio):	1:1 through 5:1
Overload Protection:	1000 VRMS
Overload Indication:	"OL" indicates a range overload. In the 1000V range, and the input > 1020.9VDC, there is also a continuous warning tone.
Lethal Voltage Indication:	Lightning bolt in LCD and double beep when the AC input exceeds 25VRMS

True RMS also works in DC amps, becoming DC and AC amps. The specifications are the same as AC amps.

Peak Hold Accuracy: 1.5% of Range

DUTY CYCLE

Frequency Ranges	Percent Range	Resolution	Accuracy (% of full scale ± digit)
40 to 20kHz	5 to 95%	0.1%	2.0% ± 1 digit

Note: Specifications are for pulsed waveforms symetrical about ground.

Response:	<1.5 sec
Input Impedance:	51 kΩ into diodes, AC Coupled
Display Bar Graph:	Not present
Overload Protection:	300VRMS
Sensitivity:	2 Vp-p Min.

Section VIII Service

Factory Service

Read the warranty located at the front of this manual before requesting warranty or non-warranty repairs.

Shipping Instructions

For in- and out-of-warranty repairs in the United States, we recommend shipping your multimeter to the factory for repair. Our factory service center features 24-hour turnaround time under normal circumstances, with a maximum of 48 hours guaranteed. Combined with low flat rate charges and fast turnaround time, the factory service center provides your best overall service alternative. (If you wish to utilize a local service facility, a list of authorized service centers in the United States can be found on the following pages.) A multimeter returned for calibration or repair should be shipped with the following: your company name (if applicable), your name, address, telephone number, proof of purchase (for warranty repairs), and any test leads used with the meter. In addition, make sure to **include a written description of the problem encountered or service required. For minimum turn-around time on out-of-warranty repairs please phone in advance for service-charge rates. Ship the multimeter with test leads in a sturdy box to the following address and marked *Attention: Instrument Repair/ Service***:

For U.S.A.:	**For U.K.:**	**For Canada:**
Wavetek	Wavetek Ltd.	(Refer to Service
Instruments Division	Datron Division	Centers-Canada
9045 Balboa Ave.	Hurricane Way	on the following pages.)
San Diego, CA 92123	Norwich, NR6 6JB, U.K.	
Tel: (619) 279-2200 ext. 670	Tel: 011-44-603-404824	
800-223-9885	Fax: 011-44-603-483670	
Fax: (619) 495-3296		

The multimeter will be returned with the shipping charge paid by Wavetek Corp. For questions in North America, contact the Instrument Repair & Service Department at (619) 279-2200 ext. 670.

Service and Shipping Instructions for Other Countries
Contact your local Wavetek Corp. dealer or distributor where the multimeter was purchased or refer to the *Service Centers - Other* list on the following pages.

See previous page for factory service center address. If local service is necessary, the following centers are authorized to repair Wavetek Corp. Instruments.

Service Centers – U.S.A.

Alabama

Arnolds Instrumentation
3258 Spring Hill Avenue
Mobile, AL 36607
(205) 478-3230

California

Wavetek
Instruments Division
9045 Balboa Ave.
San Diego, CA 92123
(619) 279-2200 Ext 670
800-223-9885
Fax: (619) 627-0132

Standard Meter Labs
236 Rickenbacher Circle
Livermore, CA 94550
(818) 960-5402

Colorado

Instrument Repair Labs
2100 W. 6th Avenue #A
Broomfield, CO 80020
(303) 469-5375

R&R Instruments
15701 E. 1st Ave., Unit 106
Aurora, CO 80011
(303)364-8325

Georgia

Peach State Instruments
869-1 Pickens Industrial Drive
Marietta, GA 30062
(404) 424-0447

Illinois

Metermaster, Inc.
2055 Army Trail Rd., Suite 134
Addison, IL 60101
(708) 268-8100

Indiana

Electro Lab Services
517 N. Fulton Avenue
Evansville, IN 47710
(812) 423-5211

Louisiana

Industrial Instrument Works
5745 Salmen Avenue
Harahan, LA 70123
(504) 733-8355

Massachusetts

Cal-Tek
20 Republic Road
N. Billerica, MA 01862
(508) 667-8541

EIL Instruments
21 'A' Street
Burlington, MA 01803
(617) 272-9450

Minnesota

Instrumentation Services
957 Winnetka Avenue North
Minneapolis, MN 55427
(612) 544-8916

Missouri

Industrial Service Labs
1530 Page Industrial Blvd.
St. Louis, MO 63132
(314) 423-3141

New York

EIC Electronics
85 Avenue "E"
Rochester, NY 14621
(716) 544-4392

EIL Instruments
9020 Wehrle Drive
Clarence, NY 14031
(716) 634-8500

Instrument Mart
295 Community Drive
Great Neck, NY 11021
(516) 487-7430

Techni-Mart
79-50 212 Street
Bayside, NY 11364
(718) 479-1890

Oklahoma

Central Instrument Labs
3158 S. 108th E. Avenue
Tulsa, OK 74146
(918) 622-0114

Ohio

Unitek
865 Cleveland Avenue
Columbus, OH 43201
(614) 291-9909

Oregon

Westcon, Inc.
5101 N. Interstate Avenue
Portland, OR 97217
(503) 283-0132

Pennsylvania

EIL Instruments, Inc.
701 Rodi Road
Pittsburgh, PA 15235
(412) 823-2255

Sunshine Instruments, Inc.
1810 Grant Avenue
Philadelphia, PA 19115
(215) 673-5600

Texas

EIL Instruments
7385 Ashcroft Street
Houston, TX 77081
(713) 271-3100

Metermaster, Inc.
3405 Express Drive
Garland, TX 75041
(214) 271-5671

Meters & Instruments
9431 Winkler Drive
Houston, TX 77017
(713) 943-1211

Virginia

Meter Metrics
7400 White Pine Road
Richmond, VA 23237
(804) 275-1431

Washington

EIL Instruments
2883 152nd Avenue NE
Redmond, WA 98052
(206) 882-3222

Service Centers – Canada

Alberta

Kingsway Aviation
4238 91 'A' Street
Edmonton T6E 5V2
(403) 463-5264

British Columbia

Miller Instruments
1-38 N. Fraser Way
Burnaby V5J 5G6
(604) 431-8882

Manitoba

Probe Industrial Electronics
1874 Portage Avenue
Winnipeg R3J 0H2
(204) 885-9320

Ontario

BCS Electronics
855 Matheson Blvd E, Unit 6
Mississauga, L4W 4L6
(905) 602-8550

Quebec

Projean Ltd.
1332 Rue Belanger East
Montreal H2G 1A1
(514) 273-8331

Primo Instruments
11235 Boul. L'Archeveque
Montreal-Nord H1H 3A8
(514) 329-3242

Service Centers – Other

Angola

Technidata Ltd.
P.O. Box 1619
Rua Reverendo Agostinho Pedro
Neto 21-21A
LUANDA
Tel: 32025/32309 Tlx: 3019

Argentina

Reycom Electronica SRL
Uruguay 362 Peso 8-Depto. F
1015 BUENOS AIRES
Tel: 54-1-11-1722
Fax: 54-1-11-1721

Australia

Bell-IRH Industries PTY
Warburton Franki Div.
32 Parramatta Road
LIDCOMBE, NSW2141
Tel: 61-02-648-5455
Fax: 61-02-647-1545

Austria

LICO - GmbH
Felbigergasse 38
A-1140 WIEN
Tel: 0222-940621 Tlx: 133378
Fax: 0222-944174

Bahrain

Al-Jishi Corporation
P.O. Box 617
Al-Khalifa Road
MANAMA
Tel: 253297 Tlx: 8371

Belgium
Mecotronic SA/NV
Nieuwelaan 58
1860 MEISE
Tel: 02-269 07 48 Tlx: 65602
Fax: 02-2699455

Brazil
Sistronics Instrumentacao E
Sistemas LTDA
Av Alfredo Agidio de Souza
Aranha 75-4 Andares
Jd. Santo Antonio
CEP 04726 Sao Paulo, SP

East Europe
Technology International
20 Haymarket Terrace
EDINBURGH EH12 5JZ
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Tel: 031-3467050 Tlx: 727563
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Scientific & Medical
Supplies Co. P.O. Box 1387
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AZ Trading Co.
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Jaber Al-Mubarak Street
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Lebanon

Elco Ltd.
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Tel: 961-894420, Tlx: 22867

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